REMARKS

I. STATUS OF THE CLAIMS

The independent claims are amended herein.

Claims 175, 176 and 177 are canceled herein.

In view of the above, it is respectfully submitted that claims 164-174 and 178-184 are currently pending.

II. REJECTION OF CLAIMS 164-184 UNDER 35 USC 103 AS BEING UNPATENTABLE OVER ANTOS, USP 5,361,319 IN VIEW OF THE KANAMORI OEC ARTICLE

The present invention as recited, for example, in claim 164, relates to a multi-stage optical amplifier including (a) a first amplifier amplifying a wavelength division multiplexed (WDM) optical signal, (b) a dispersion compensator compensating dispersion given to the amplified WDM optical signal and outputting a dispersion compensated WDM optical signal, and (c) a second amplifier amplifying the dispersion compensated WDM optical signal.

Therefore, in the present invention as recited, for example, in claim 164, the first amplifier, the dispersion compensator and the second amplifier are not simply dispersed along the transmission line in an unrelated manner. Instead, these elements are included within a multi-stage optical amplifier. There are many advantages of a multi-stage optical amplifier which provides amplification and dispersion compensation, with a dispersion compensator between optical amplifiers, as compared to individual amplifiers and dispersion compensators being dispersed along the transmission line in a generally unrelated manner. See, for example, FIGS. 37, 38 and 39, and the disclosure on page 103, line 19, through page 106, line 14, of the specification. See especially page 106, lines 6-14, of the specification.

1. Antos

The Examiner asserts that, in FIG. 14 of Antos, OFA-2, the DC fiber, and OFA-3 together form a multi-stage optical amplifier.

However, it is respectfully submitted that, in FIG. 14 of Antos, OFA-2 is positioned somewhere along the transmission line, but not in the same multi-stage optical amplifier as

OFA-3. For example, FIG. 14 of Antos does not show any enclosure enclosing both amplifiers OFA-2 and OFA-3. Column 17, lines 33-58, of Antos, relate to FIG. 14 of Antos, but do not disclose or suggest that OFA-2 is in the same multi-stage optical amplifier as OFA-3.

FIG. 14 of Antos shows a "dotted box" around the DC fiber (22 km), OFA-2 and DC fiber (11km). However, it is clear that this "dotted box" does not include OFA-2. Moreover, this "dotted box" is not intended to represent any type of multi-stage optical amplifier. Instead, from column 17, lines 53-57, of Antos, it is clear that the "dotted box" in FIG. 14 is used to show that a total length of DCF (22km + 11 km) was divided into two sections, to increase the power level at the input of OFA-3. Accordingly, in FIG. 14 of Antos, a "dotted box" around the DC fiber (22 km), OFA-2 and DC fiber (11km), along with another "dotted box" around DC fiber (6.4 km), is used to highlight the relationship between the various DC fibers in the system.

Further, Antos does not disclose or suggest any reason to include OFA-2, DC fiber (11 km) and OFA-2 in the same multi-stage optical amplifier.

Therefore, it is respectfully submitted that FIG. 14 of Antos shows optical amplifiers and DC fibers dispersed along the transmission line, but does not show a "multi-stage optical amplifier" which includes a first amplifier, a dispersion compensator, and a second amplifier, as recited, for example, in claim 164.

Moreover, as indicated above, the claims recite the amplification and dispersion compensation of a "WDM" optical signal.

FIG. 14, and the corresponding disclosure in column 17, lines 33-58, of Antos, do not disclose or suggest the amplification of a WDM optical signal. Instead, it is respectfully submitted that FIG. 14 simply shows a pattern generator generating and transmitting a 10 Gbit/sec signal. This 10 Gbit/sec signal is NOT a WDM optical signal.

For example, as disclosed in column 17, lines 48-53 of Antos, relating to FIG. 14 of Antos, "OFA#2 was a 980 nm forward-pumped, 25dB gain amplifier, followed by a 1.2 nm bandpass optical filter. OFA#3 comprised two 980 nm backward-pumped amplifiers resulting in 31dB gain, with a saturated output power of +13dBm, followed by a 3 nm bandpass optical filter." Either the 1.2 nm bandpass filter or the 3 nm bandpass filter has a very narrow bandwidth, so it is impossible for the optical amplifier disclosed in FIG. 14 of Antos to amplify a WDM optical signal and for the dispersion compensator disclosed in FIG. 14 of Antos to compensate the dispersion of a WDM optical signal. Rather, this portion of Antos teaches away

from amplifying a WDM optical signal by an optical amplifier or compensating for dispersion of the WDM optical signal by a dispersion compensator.

On page 6, lines 5-10, of the outstanding Office Action, the Examiner asserts that the Applicant's arguments that FIG. 14 of Antos teaches away from WDM usage is not convincing. More specifically, the Examiner asserts "Antos et al teaches both the benefits of it's figure 14 multistage fiber amplifier, and discloses (col. 2, lines 49-54) dispersion flattened fibers also having the benefit of reduced slope around the zero crossing, thereby enabling low dispersion transmission over a wide range of wavelengths near the transmission wavelength. " The Examiner makes a similar assertion on page 3, lines 9-15, of the outstanding Office Action.

However, it is respectfully submitted that col. 2, lines 49-54, cited by the Examiner, is directed to general background information. This information is NOT directed to the embodiment in FIG. 14 of Antos. Instead, in accordance with the above comments, the Applicants again reassert that FIG. 14 of Antos does not disclose or suggest the amplification of a WDM optical signal.

FIG. 2 of Antos shows the use of WDM. More specifically, FIG. 2 of Antos discloses a WDM optical signal including light at 1310 nm and 1550 nm multiplexed together.

However, the 1310 nm and 1550 nm lights are demultiplexed by coupler (demultiplexer) 16. The demultiplexed light at 1550 nm is optically amplified by an optical amplifier 13. The demultiplexed light at 1310 is amplified by a conventional "electrical" repeater 17, which converts the light to an electrical signal, amplifies the electrical signal, and then converts the amplified electrical signal into an optical signal. See, for example, column 8, lines 50-65, of Antos.

More specifically, as disclosed in column 8, lines 58-62 of Antos, "The 1310 nm signal is processed by conventional repeater 17, and the 1550 nm signal is amplified by OFA 13 and its dispersion is compensated by dispersion compensating fiber 14." (Please note that DCF 14 in FIG. 2 provides dispersion compensation to light amplified by OFA 13, but NOT to light amplified by repeater 17.) Thus, FIG. 2 of Antos does NOT disclose an optical amplifier amplifying a WDM optical signal. Moreover, FIG. 2 of Antos does NOT disclose a dispersion compensator compensating for dispersion of a WDM optical signal.

Therefore, it is respectfully submitted that no portion of FIG. 2 discloses a WDM optical signal being amplified by a multi-stage optical amplifier, as recited, for example, in claim 164.

Instead, in FIG. 2 of Antos, each wavelength is demultiplexed and individually amplified. Moreover, it is respectfully submitted that no portion of FIG. 2 discloses dispersion compensation, arranged in the mid-section of the multi-stage optical amplifier, of a WDM optical signal.

Therefore, it is respectfully submitted that no portion of Antos discloses or suggests a "WDM" optical signal which is amplified and dispersion compensated by a "multi-stage optical amplifier", as recited, for example, in claim 164.

2. Kanamori

The Examiner asserts that Kanamori shows the use of WDM signaling, and that it would be obvious to combine the WDM signaling of Kanamori with Antos.

However, as indicated above, due to the use of the bandpass filters in FIG. 14 of Antos, it is impossible for the optical amplifier disclosed in FIG. 14 of Antos to amplify a WDM optical signal and for the dispersion compensator disclosed in FIG. 14 of Antos to compensate the dispersion of a WDM optical signal. Therefore, it is respectfully submitted that it would be improper to combine the WDM disclosed in Kanamori with Antos.

Moreover, as it is impossible for the optical amplifier disclosed in FIG. 14 of Antos to amplify a WDM optical signal and for the dispersion compensator disclosed in FIG. 14 of Antos to compensate the dispersion of a WDM optical signal, Antos can be seen as "teaching away" from any WDM taught by Kanamori.

In addition, Kanamori does not disclose or suggest that the transmitted signal is a "WDM" optical signal. For example, item 4 on page 288 of Kanamori, discloses the use of WDM couplers to couple pump light to a signal light. FIG. 1 of Kanamori illustrates this use of a WDM coupler. As would be understood from FIG. 1, the WDM coupler couples the pump light to the signal light. No portion of Kanamori discloses or suggests that the signal light is a "WDM" optical signal.

On page 6, lines 14-16, of the outstanding Office Action, the Examiner asserts that "although Kanamori may also be referring to multiplexing pump and signal wavelengths onto the fiber, this does not detract from the general disclosure of WDM usage." However, it should be noted that the claims of the present application specifically recite a "WDM" optical signal. It is respectfully submitted that it would be well-understood in the art that a WDM optical signal

refers to a plurality of optical signals having different wavelengths multiplexed together. A pump light is not an optical signal. Therefore, it is respectfully submitted that the transmission of a WDM optical signal as in the claimed invention, is significantly different than the multiplexing of a respective signal light with pump light as in Kanamori.

Moreover, it is respectfully reasserted that no portion of Kanamori discloses or suggests that the signal light is a "WDM" optical signal.

Accordingly, it is respectfully reasserted that no portion of Kanamori discloses or suggests that the signal light is a "WDM" optical signal.

3. A dispersion compensator, arranged in the mid-section of a multi-stage optical amplifier, compensating dispersion given to an amplified WDM optical signal and outputting a dispersion compensated WDM optical signal

The present invention as recited, for example, in claim 164, relates to a dispersion compensator, arranged in the mid-section of a multi-stage optical amplifier, compensating dispersion given to a WDM optical signal and outputting a dispersion compensated WDM optical signal.

As indicated above, Antos does not disclose or suggest a WDM optical signal being compensated by a dispersion compensator.

Further, as indicated by the following remarks, it is respectfully submitted that, at the time of the present invention, the prior art did not disclose or suggest the use of a dispersion compensator, arranged in the mid-section of a multi-stage optical amplifier, to compensate dispersion given to a "WDM" optical signal.

The following four references, which will be referred to in the following remarks, were previously submitted in the IDS filed July 14, 2003:

Reference 1) Ivan P. Kaminow et al., "Optical Fiber Telecommunications IIIB", published by Academic Press in 1997, pages 36 and 66 in Chapter 2, Erbium-Doped Fiber Amplifier;

Reference 2) C.D. Chen et al., "A Field Demonstration of 10Gb/s - 360km Transmission Through Embedded Standard (non-DSF) Fiber Cables", OFC '94 (February 20-25, 1994), PD27-1;

Reference 3) Ivan P. Kaminow et al., "Optical Fiber Telecommunications IIIA", published

by Academic Press in 1997, pages 181 and 191 in Chapter 7, Dispersion Compensation for Optical Fiber Systems;

Reference 4) J-M.P. Delavaux et al., "COBRA: Compensating Optical Balanced Reflective Amplifier", ECOC '94 (September 25-29, 1994), pp.5-9, Proceedings Vol.4, Post-deadline Papers.

Please note that all the above references were published AFTER the priority dates (August 10, 1993 and September 29, 1993) of the present application.

On lines 2-11 in page 36 of Reference 1, it is disclosed:

The use of dispersion-compensating fiber (DCF) offers the possibility of upgrading the embedded fiber network with multigigabit 1.5-μm amplified repeatered transmission systems. However, the additional transmission loss incurred by the addition of DCF needs to be overcome by additional in-line amplifiers. As an example, a recent field trial demonstrating 10-Gb/s transmission through 360km of non-dispersion-shifted installed fiber uses <u>three in-line EDFA repeater modules, each comprising a DCF sandwiched between two tandem optical amplifier configurations.</u>[40] The spacing between repeaters was 120km, corresponding to a 33-dB optical span margin. (emphasis added)

Referring to page 66 of Reference 1, it is shown that Reference 2 corresponds to the cited reference 40 related to configuration of the above discussed in-line EDFA repeater modules. Reference 2, section 2, "10 Gb/s System Hardware", discloses:

The 10Gb/s system hardware are shown in Figure 1. Figure 1(a) shows an AT&T standard shelf which contains a transmitter, a receiver and an auto tracking filter plug-in modules. <u>The transmitter consists of a 1552 nm (or 1557 nm) DFB laser and a Ti:$LiNbO_3$ external modulator.</u> The receiver includes a p-i-n HEMT front end and clock-data recovery circuitry. The auto tracking filter (40GHz bandwidth) automatically acquires the optical signal and locks its transmission peak to the signal wavelength. Figure 1(b) shows rack-mounted repeater shelves (and two Tx/Rx shelves). Each optical repeater consists of <u>two Er-doped fiber amplifiers (EDFAs) with a dispersion compensation fiber (DCF) in the middle.</u> (emphasis

added)

Further, in Reference 2, section 4, "Conclusion", discloses:

> We have demonstrated, for the first time, 10Gb/s long haul transmission through embedded standard fiber cables. <u>Optical repeaters incorporating low noise EDFAs and DCFs enabled us to operate the 10Gb/s transmission system through 360km non-DSF with repeater spacing of 120km.</u> The high system stability has been clearly demonstrated by "error-free" transmission for 11 consecutive days ($<10^{-16}$ BER). (emphasis added)

Thus, it is evident that References 1 and 2 disclose that the arrangement of a dispersion compensating device in the midsection of a multi-stage optical amplifier was used, NOT for amplifying a WDM optical signal, but for amplifying a "single wavelength" optical signal.

This arrangement is also disclosed in Reference 3. Lines 25-31 in page 181 of Reference 3 discloses:

> Thus, a high-FOM compensating fiber will increase each span loss by about 30%. Because loss budgets will usually not absorb such a large loss, an amplifier is usually placed between the span and the compensating fiber. The high cost of this gain stage can be mitigated somewhat in system designs that require <u>two-stage or three stage amplifiers because, in that case, the DCF can be placed between gain stages (Delavaux et al. 1994).</u> (emphasis added)

Referring to page 191 of Reference 3, it is shown that Reference 4 corresponds to the cited reference "Delavaux et al. 1994," relating to a configuration in which a DCF is placed between gain stages. In Reference 4, the first paragraph of section 2, "Amplifier configuration" discloses:

> The proposed amplifier (COBRA) is described schematically in Figure 1. The configuration is inspired from previous balanced optical amplifier (BOA) designs[5-6]. The amplifier consists of three stages: <u>One compensation stage sandwiched</u>

> between a pre- and post-amplifier stage. The first stage (I1) provides a combination of high gain and low noise figure while the second stage (I2) delivers a high output power, hence maintaining a high signal to noise ratio. Both EDFA stages are pumped through wavelength multiplexer (MUXI & II) and a 3dB coupler (C) by a pair at semiconductor pump lasers. Here, the 980nm pump wavelength was used to take advantage of the possibility of near quantum limit inversion of the active fiber and the high electro-optic conversion efficiency. After amplification by the first stage, the signal enters the circulator and propagates twice through the dispersion compensating means upon reflection by the Faraday rotator mirror (FRM). Before entering the circulator, the signal passes through a band-pass filter that prevents early saturation of the second stage by the amplified spontaneous emission (ASE) outside the signal band. (emphasis added)

Further, in Reference 4, the fifth paragraph of section 4, "Amplifier performance", discloses:

> Furthermore, the COBRA was used with a DCF with 915ps (4.8 dB) of total dispersion (loss) before the 10Gb/s receiver[2] to compensate 2156 ps of dispersion due to the transmission through 122km SMF at 1557nm. Figure 7 compares the transmission eyes with and without compensation at a 10^{-9} BER with a 2^{23} -1 NRZ modulation format: complete compensation was achieved with half the required compensation length. (emphasis added)

Thus, it is evident that References 3 and 4 also disclose that the arrangement of a dispersion compensating device in the midsection of a multi-stage optical amplifier was used, NOT for amplifying a WDM signal, but for amplifying a "single wavelength" optical signal.

According to the above remarks, it is clear that, even after the Japanese priority dates of the present application, the arrangement of a dispersion compensating device in the midsection of a multi-stage optical amplifier was directed to a "single wavelength" optical signal among the people skilled in the art, although the advantage of this arrangement was appreciated after the Japanese priority dates of the present application.

In view of the above, it is respectfully submitted that the claimed invention is not obvious over the prior art.

To further distinguish over the combination of references, independent claim 164 is amended to recite that channel spacing between a pair of adjacent signal channels is set to an integer multiple of a minimum channel spacing defined in terms of an optical frequency or an optical wavelength. Similar amendments are made to the other independent claims. Support for the amendments is found, for example, in FIG. 8, and on page 46, line 16, through page 47, line 11, of the specification.

In view of the above, it is respectfully submitted that the rejection is overcome.

III. CONCLUSION

In view of the above, it is respectfully submitted that the application is in condition for allowance, and a Notice of Allowance is earnestly solicited.

If any further fees are required in connection with the filing of this response, please charge such fees to our Deposit Account No. 19-3935.

Respectfully submitted,

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